EFFICIENT AND HEALTHY SCHOOLS

2022 Efficient and Healthy Schools Webinar Series

Webinar 1 of 4: Ongoing Monitoring and Analytics for HVAC Performance

U.S. Department of Energy and Lawrence Berkeley National Laboratory

May 6, 2022

Efficient and Healthy Schools Campaign Webinar

Welcome!

- Agenda is in the chat
- Webinar is being recorded
- All attendees are muted
- Please enter questions into the chat and they will be answered during the question and answer section
- We will be notifying speakers when they are over the time limit

Today's Webinar

- Opening Remarks – Sam Petty, U.S. Department of Energy
- Recognition Program – Rengie Chan, Berkeley Lab
  - Best in Class – Doug Anderson, Davis School District, UT
  - Notable Achievement – Shannon Oliver, Adams 12 Five Star School, CO
- Energy Management and Information Systems (EMIS) – David Landman, Berkeley Lab / Pure Energy Information Solutions

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Energy Improvements in Public School Facilities

May 6th, 2022

Sam Petty
Sarah Zaleski
Carl Shapiro

Building Technologies Office

BTO invests in energy efficiency & related technologies that make homes and buildings more affordable and comfortable, and make the US more sustainable, secure and prosperous.

Budget ~US$285M/year; activities include:

R&D

Pre-competitive, early-stage investment in next-generation technologies

Integration

Technology validation, field & lab testing, metrics, market integration

Codes & Standards

Whole building & equipment standards technical analysis, test procedures, regulations

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

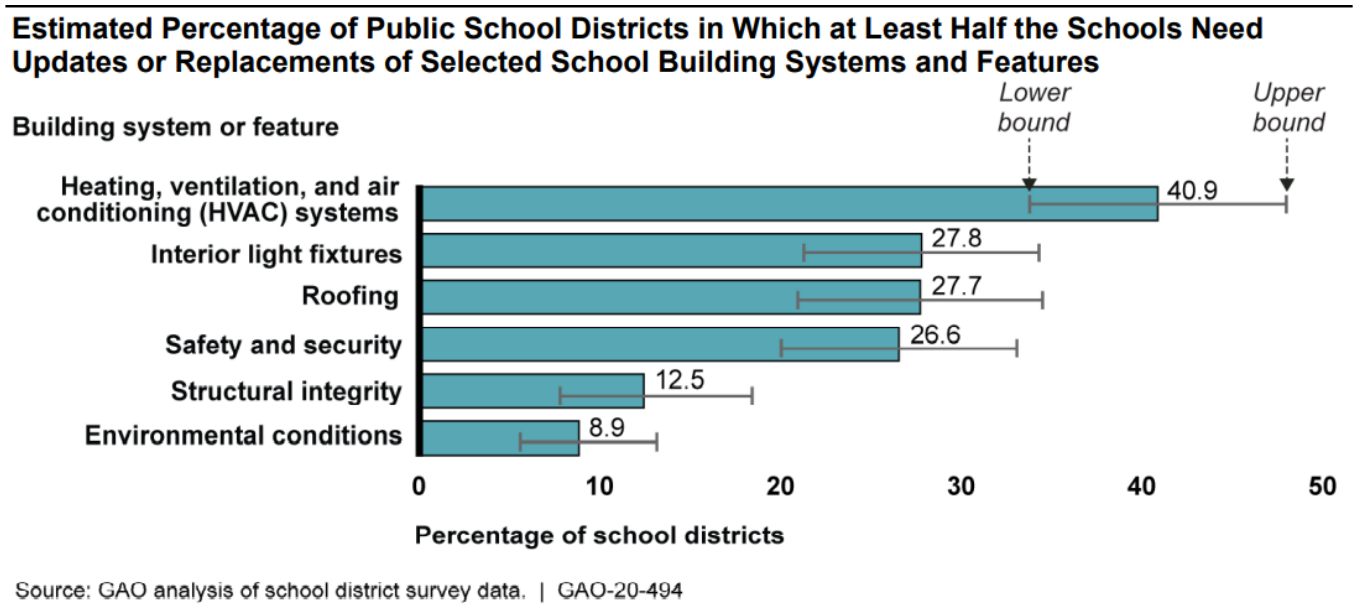
What is the Need/Opportunity?

Public K-12 schools have significant facilities needs

- Schools are the **second largest** public infrastructure sector and has minimal historic federal investment
- At **least one-third** of US schools need updated HVAC systems
- **$85 billion annual shortfall** in maintenance and capital funding needed for school facilities
- Capital improvement needs are greatest in **rural, high-poverty schools**

Why does it matter?

- Poor indoor environmental quality **reduces student learning and health**
- Antiquated school facilities **disproportionately impact** J40 communities
- Utility costs **reduce $ for classrooms**



BIL programs and eligibility under ESSER funding ($176B) is a **historic opportunity** to demonstrate the benefits of national investment in public school infrastructure to

- Remedy the historic inequity of school facilities investments
- Reduce school energy expenditures
- Help schools lead the nation in solving the climate crisis

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TA Currently Available - Efficient and Healthy Schools Campaign

EFFICIENT AND HEALTHY SCHOOLS

In partnership with the ED and EPA, the campaign helps public K-12 schools identify practical HVAC solutions and upgrades to improve energy efficiency and indoor air quality.

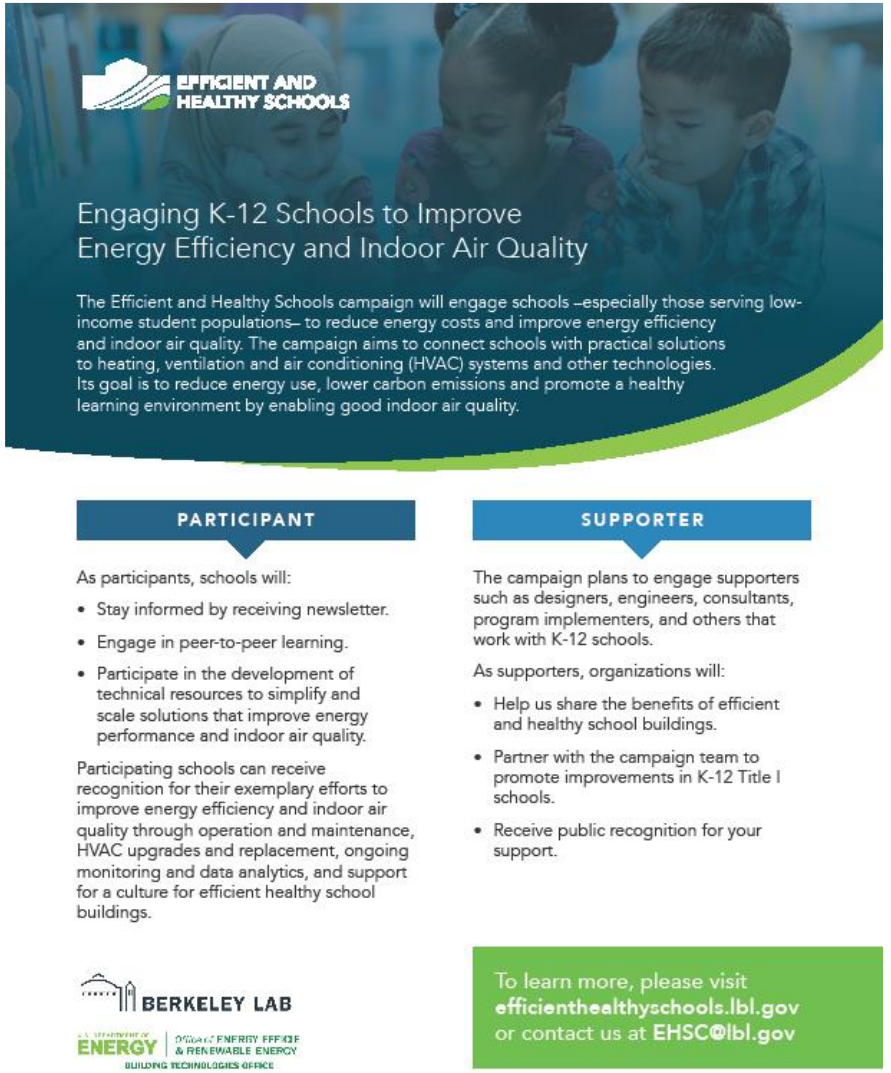
Technical Assistance will provide participating schools and districts with:

1. General resources on EE retrofits, low carbon technologies, and financing options.
2. Specific guidance on energy management tools
3. Information about managing and improving indoor air quality.
4. Offer technical review and data gathering service to participating schools and districts.

Campaign Update

First round of recruitment completed with 23 recruits, 850 Schools representing the states of CA, CO, KS, LA, MA, MI, MO, ND, NJ, OH, SC, UT, WI, WY.

https://efficienthealthyschools.lbl.gov/about



U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

40541 – Grants for Energy Improvements at Public School Facilities

Overview: Grants for energy efficiency improvements and renewable energy improvements at public school facilities.

Qualifying Energy Improvements: Improvements, repairs, or renovations that reduce energy costs or lead to improved teacher and student health and achieve energy savings, installation of renewable energy, installation of alternative fueled vehicle infrastructure, and purchases or leases of alternative fueled vehicles.

Eligible Entities: Consortia of 1 local educational agency (LEA) and one or more schools, non-profits, for-profits, or community partners. LEA Definitions include School Board, Bureau of Indian Education Schools, Educational Service Agencies

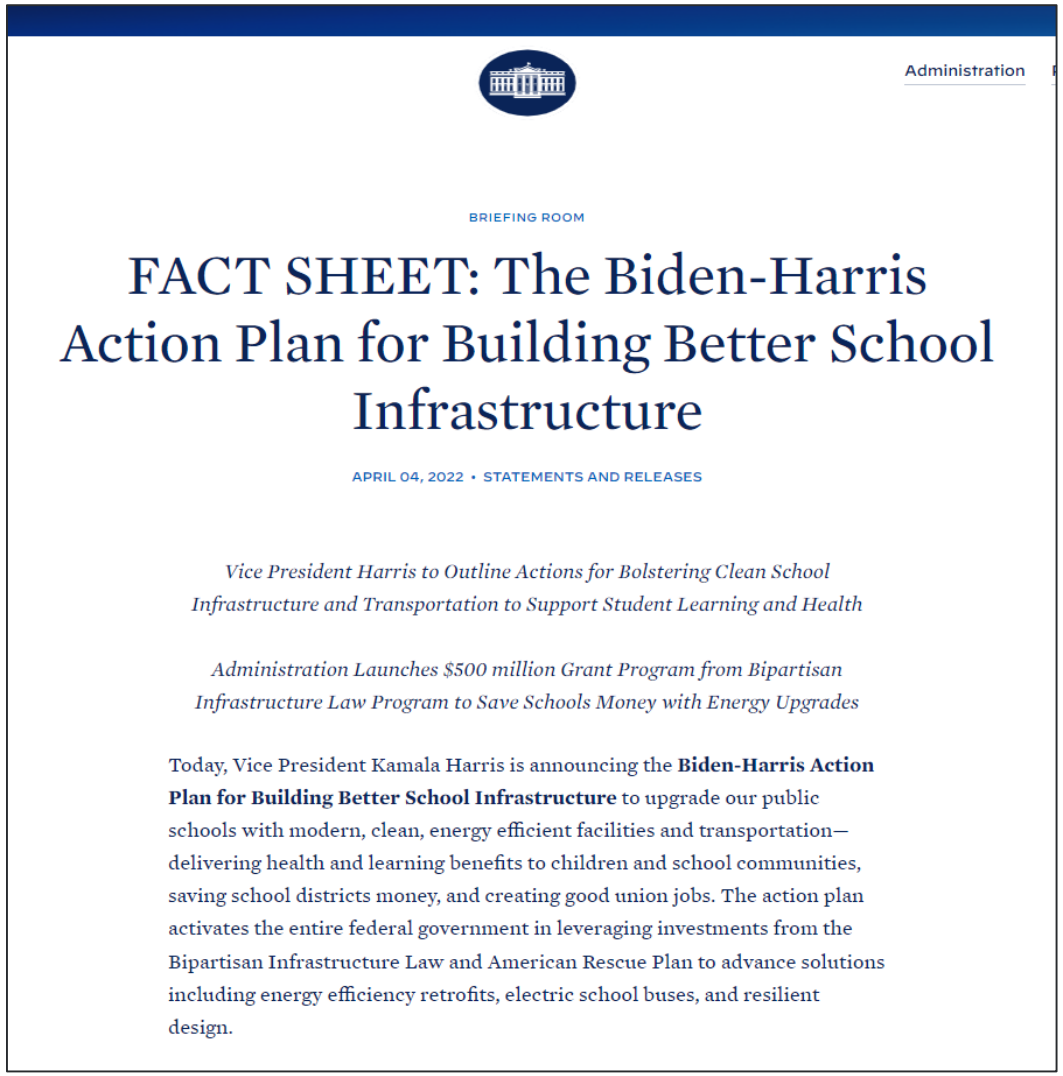
Prioritization: Schools with improvement funding needs, high free and reduced-price lunch percentage or rural locale, and leverage private sector funding through performance contracting.

Funding: $500M ($100M over five years), until expended, through competitive grants

DOE at Center of Building Better Schools Action Plan

The Biden-Harris Action Plan for Building Better School Infrastructure will:

Invest in More Efficient, Energy-Saving School Buildings: The Department of Energy (DOE) is launching a $500 million grant program through President Biden's Bipartisan Infrastructure Law to make public schools more energy efficient. This new program will lower energy costs, improve air quality, and prioritize schools most in need, enabling schools to focus more resources on student learning.



Administration

BRIEFING ROOM

FACT SHEET: The Biden-Harris Action Plan for Building Better School Infrastructure

APRIL 04, 2022 • STATEMENTS AND RELEASES

Vice President Harris to Outline Actions for Bolstering Clean School Infrastructure and Transportation to Support Student Learning and Health

Administration Launches $500 million Grant Program from Bipartisan Infrastructure Law Program to Save Schools Money with Energy Upgrades

Today, Vice President Kamala Harris is announcing the **Biden-Harris Action Plan for Building Better School Infrastructure** to upgrade our public schools with modern, clean, energy efficient facilities and transportation—delivering health and learning benefits to children and school communities, saving school districts money, and creating good union jobs. The action plan activates the entire federal government in leveraging investments from the Bipartisan Infrastructure Law and American Rescue Plan to advance solutions including energy efficiency retrofits, electric school buses, and resilient design.

Goal of Program Design

Execute program in a way that:

- facilitates substantial additional investment,
- prioritizes schools with high needs,
- minimizes administrative burden, and
- builds enduring capacity in local educational agencies to maximize impact equitably and efficiently.

Strategy: Positioning Provision as a Launchpad for MAJOR investment

Imperative to use this $500M down payment to pave the way for a much larger national investment in school facilities through additional federal (and other) funding streams by:

- Building school capacity to manage retrofits and facilities
- Teeing up future projects and investment through widespread needs assessments
- Facilitating organizational infrastructure and business models to execute partnerships
- Coalescing stakeholders around need and potential for impact
- Creating shared ownership of inspiring stories that help communities

Request for Information Now Open

Goal: Solicit public feedback related to maximizing impact with the program and signal to stakeholder of upcoming funding opportunity

Audience: potential applicants (local educational agencies) and broader stakeholders well-positioned to support work including state educational agencies, ESCOs, unions, service providers, utilities, non-profits and funders, community partners, manufacturers, etc.

RFI Question Categories

1. Capacity development
2. Needs assessments
3. Metrics and criteria
4. Leveraging funds
5. Partnership structures
6. Workforce

Closes May 18th

https://eere-exchange.energy.gov/Default.aspx#FoaId2f565267-7810-4605-b85b-a48e6ef98708

EFFICIENT AND HEALTHY SCHOOLS

Efficient and Healthy Schools Campaign

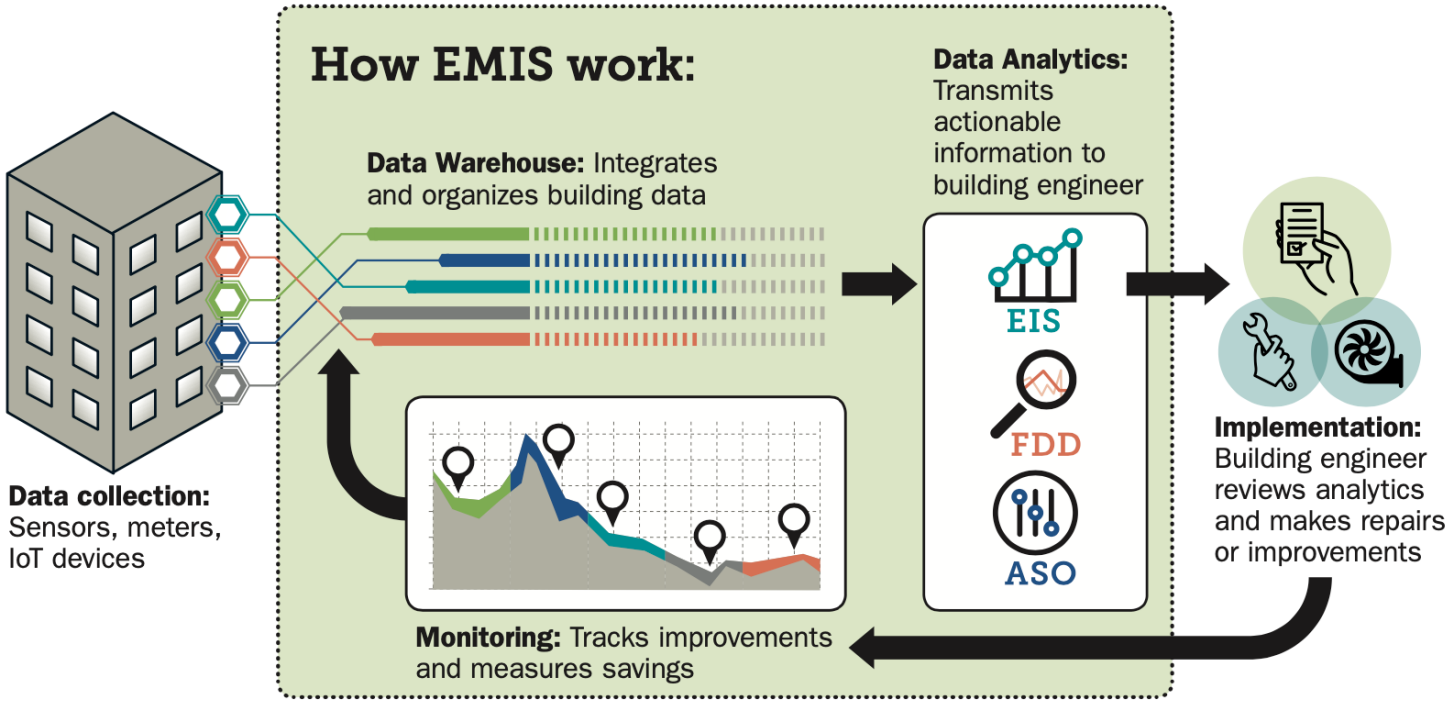
The campaign aims to engage K-12 schools to improve energy performance and indoor air quality, with a focus on practical solutions involving HVAC and other technologies to reduce energy use and carbon emissions. This campaign is led by the U.S. Department of Energy with technical support from Lawrence Berkeley National Laboratory.

Organizing partners:

Recognition Program: 2021 Round One

The Efficient and Healthy Schools Campaign aims to recognize schools and school districts that have implemented exemplary solutions involving HVAC upgrades and other approaches to reduce energy costs, and improve energy efficiency and indoor air quality.

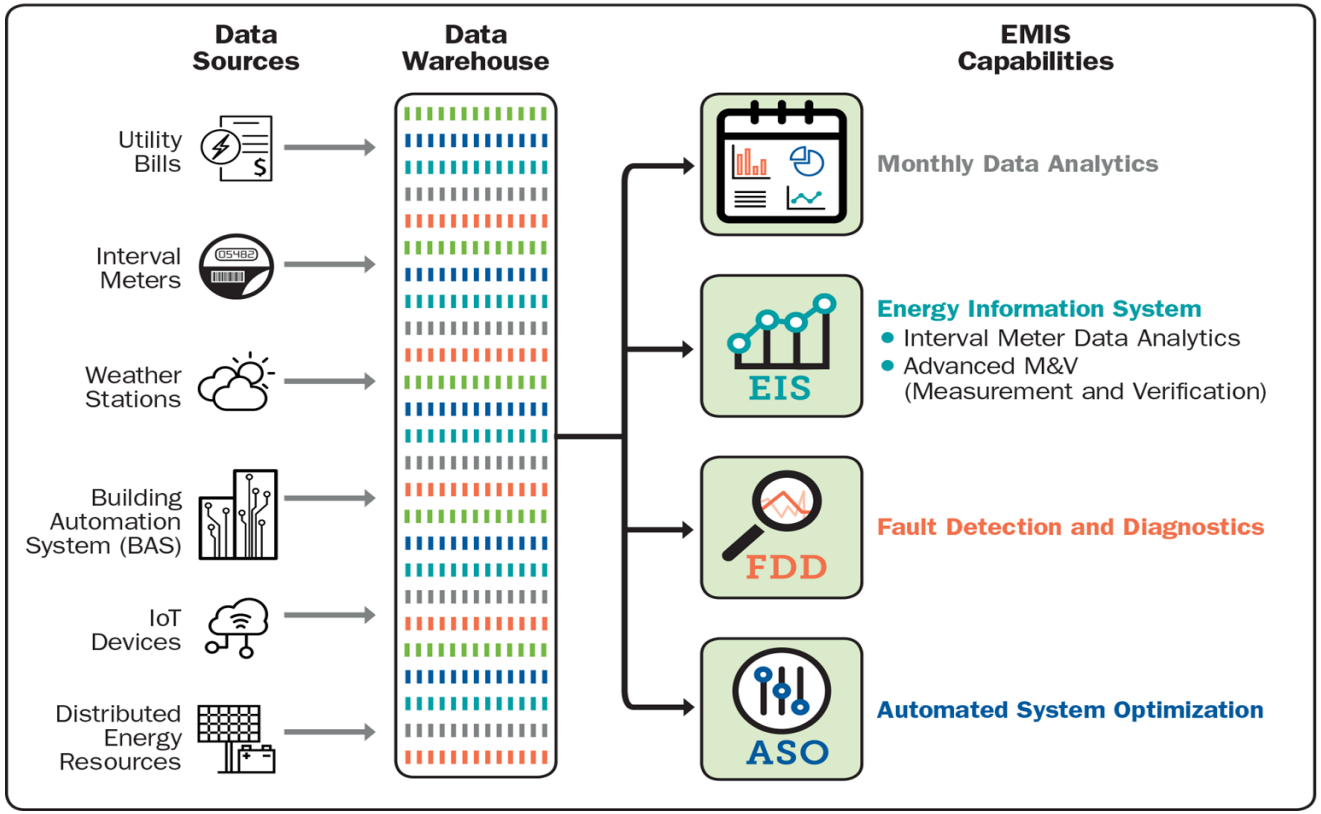
Areas for Recognition



EMIS TOOLS: Energy information systems (**EIS**) help find energy waste using smart meter data. Fault detection and diagnostic tools (**FDD**) detect and prioritize HVAC system faults. Automated system optimization (**ASO**) includes control algorithms to minimize energy use across systems.

- Schools and school districts that use energy management and information systems (EMIS) to improve HVAC performance and operation through fault detection and diagnostics, benchmarking, and commissioning.

Ongoing Monitoring and Analytics for HVAC Performance



https://smart-energy-analytics.org/

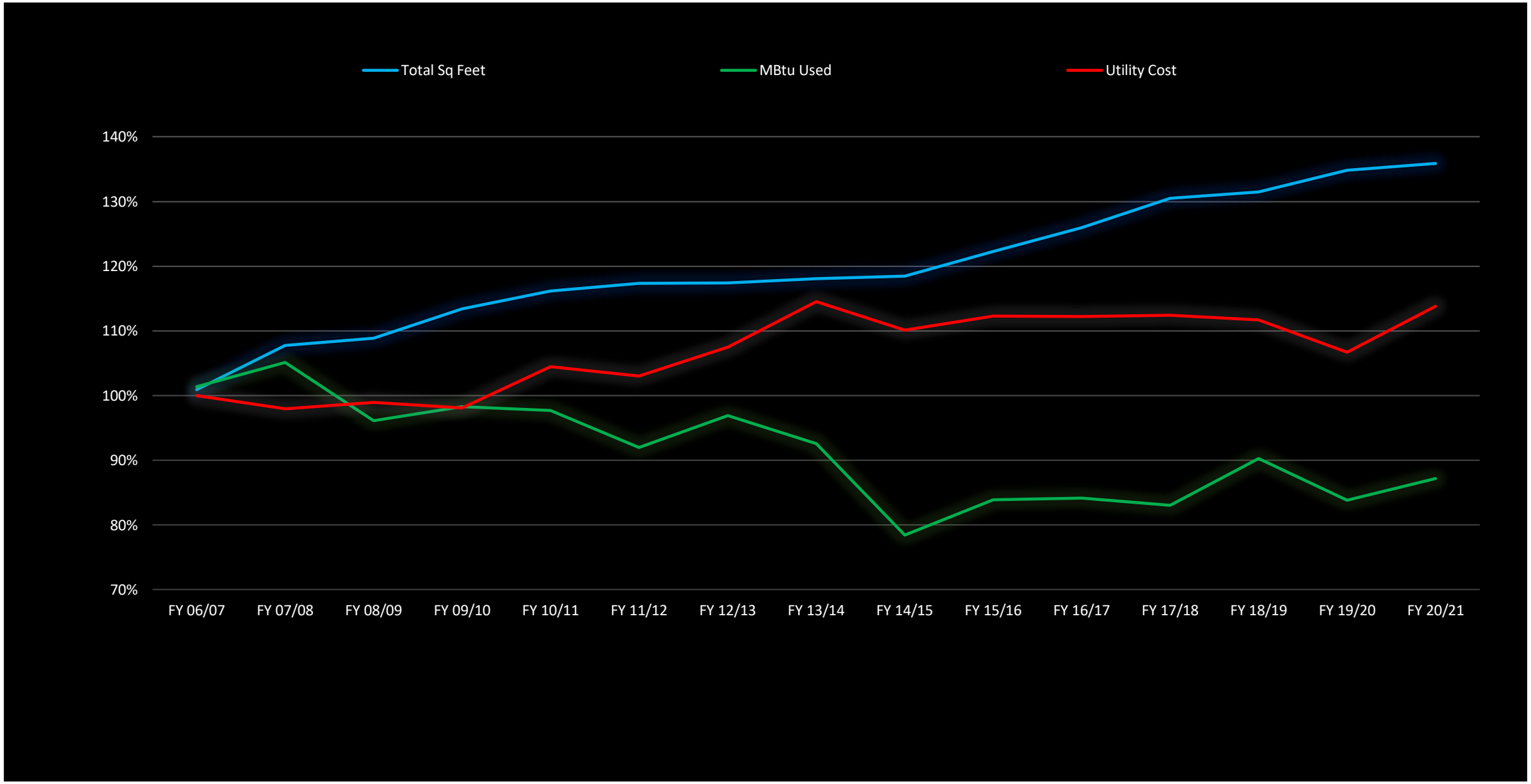
- Utilize energy management and information system (EMIS) for performance tracking, monitoring, and verification
- Provide EMIS training to staff
- Communicate results with school community to encourage involvement in energy efficiency

Davis School District's Energy Management Program

Davis School District

Employees	8,000+
Students	71,643
Elementary Schools	62
Junior High Schools	17
High Schools	9
Alternative Schools	3
Support Services	22
Total Buildings	113
Portable Classrooms	350

Schools and Support Building sf	11,204,391


Total Sq Feet
MBtu Used
Utility Cost
140%
130%
120%
110%
100%
90%
80%
70%
FY 06/07
FY 07/08
FY 08/09
FY 09/10
FY 10/11
FY 11/12
FY 12/13
FY 13/14
FY 14/15
FY 15/16
FY 16/17
FY 17/18
FY 18/19
FY 19/20
FY 20/21

Year	FY 05/06	FY 06/07	FY 07/08	FY 08/09	FY 09/10	FY 10/11	FY 11/12	FY 12/13	FY 13/14	FY 14/15	FY 15/16	FY 16/17	FY 17/18	FY 18/19	FY 19/20	FY 20/21
Total Sq Feet	100%	101%	108%	109%	113%	116%	117%	117%	118%	118%	122%	126%	131%	131%	135%	136%
MBtu Used	100%	101%	105%	96%	98%	98%	92%	97%	93%	78%	84%	84%	83%	90%	84%	87%
Utility Cost	100%	100%	98%	99%	98%	104%	103%	107%	115%	110%	112%	112%	112%	112%	107%	114%
Heating DD	100%	108%	118%	103%	115%	110%	96%	104%	97%	83%	93%	92%	86%	104%	99%	96%
Cooling DD	100%	105%	110%	86%	85%	80%	104%	118%	118%	103%	106%	117%	127%	102%	113%	134%
Students	100%	100%	101%	101%	102%	105%	106%	106%	107%	108%	110%	111%	112%	113%	109%	111%
Water Usage	100%	100%	113%	149%	146%	90%	91%	83%	72%	58%	55%	58%	66%	64%	69%	74%
kWh Usage	100%	100%	106%	106%	104%	104%	105%	107%	101%	102%	103%	103%	102%	105%	97%	105%
Gas Usage	100%	100%	88%	88%	84%	88%	79%	82%	63%	67%	66%	67%	66%	76%	70%	70%
Total Sq Feet	8,238,742	8,314,287	8,878,748	8,970,860	9,342,803	9,571,936	9,670,210	9,672,896	9,725,527	9,757,896	10,076,509	10,375,890	10,753,626	10,830,744	11,108,359	11,196,367
MBtu Used	478,653	485,245	503,129	460,144	470,527	467,581	440,334	463,925	443,225	375,611	401,462	402,898	397,582	432,049	401,222	417,256
Utility Cost	$7,206,829	$6,835,099	$7,062,194	$7,130,071	$7,067,124	$7,529,695	$7,426,950	$7,744,625	$8,252,197	$7,935,976	$8,094,098	$8,086,050	$8,101,592	$8,048,332	$7,690,626	$8,202,828
Heating DD	5,204	5,635	6,175	5,374	5,988	5,741	5,012	5,458	5,056	4,363	4,822	4,784	4,486	5,395	5,172	5,015
Cooling DD	1,369	1,450	1,507	1,182	1,157	1,097	1,431	1,629	1,617	1,413	1,453	1,606	1,738	1,401	1,548	1,833
Student Count		64,551	65,014	65,452	66,019	67,736	68,342	68,571	69,139	69,879	71,021	71,908	72,264	72,897	70,643	71,643
Water kGals	528,476	512,018	579,632	760,699	750,020	459,448	465,606	423,916	366,285	294,728	281,553	295,559	337,735	326,636	353,743	377,650
KWh	54,681,960	54,183,730	57,611,201	57,313,434	56,333,159	56,169,680	57,027,842	57,903,862	54,805,198	55,171,680	55,625,167	55,544,572	55,315,743	56,724,682	52,625,783	56,899,528
Natural Gas	292,078	316,620	278,476	278,090	266,980	279,290	248,651	258,324	200,747	212,999	209,574	213,388	209,554	239,054	221,663	223,115
Tons C02 Emitted	64,291	61,835	64,455	60,029	59,212	58,326	56,940	58,993	56,923	51,222	51,675	50,641	50,223	53,028	49,355	53,107
Renewable Generation															2,182,108	2,309,787

How is this possible?

- HVAC Upgrades
- Automation Upgrades
- Equipment Off/Setback When Not Needed
- Auditing Utility Bills/Tracking Energy Consumption
- Analytical Control/Strategies
- Energy Committee (Training Staff)
- Monitoring Buildings In Extreme Temperatures
- Water Monitoring
- Retro-Commissioning
- Replacing Windows/Roofs/Insulation
- Renewable Energy
- LED Lighting Upgrades
- Zero Energy Building Design
- Obtainable Goals
- Utility Incentives

Davis School District Current Goals

- Documentation
- Analytics
- Water Management
- LED Lighting
- Retro-Commissioning
- Attack Buildings With > 45 Kbtu/sqft
- Built To Last

What EMIS Systems Does Davis District Use?

- Schneider Electric's EcoStruxure Platform
  - 11 million SQFT
- Dude Solutions Energy Manager Cloud Software
  - 2946 meters and 1268 accounts
- Encore Oracle Database
  - work orders, portable classroom controls and building scheduling
- Various Lighting Systems
- Photovoltaic Monitoring
- Computer Shutdown Management System

Training Staff in Davis School District

- 24 Hour Monitoring Team – All Buildings Are Scheduled Through Them
- Train Facility Managers Once A Year On EMIS
- Present To The Board of Education On Energy Goals And Numbers
- Website With Up-To-Date Information
- Energy Committee
  - Custodial, New Construction, IT, Maintenance, Energy Auditor and Administration
- Help Documents, Specs And Notes In The Building Automation System
- Meet With Architects And Engineers On New Construction/Remodels

The Benefits of Training

- Team Participation
  - Facility Managers Calling In Energy Related Issues
  - Excitement and Ownership Of The Program
  - As Simple As Turning Off Lights And Equipment
  - Knowledge Of How The Buildings Operate
  - Bring Their Knowledge And Ideas To The Table
  - Trust

Reinvestment of Utility Incentives

- To Date Davis District has Received $1,604,078.13
  - Reinvest Them Into The Energy Program
  - Be Aware Of Where Incentives Are Going
  - Work With Your Utility To Learn About What Is Available
  - This Money Is Available And Is Real

Recommendations

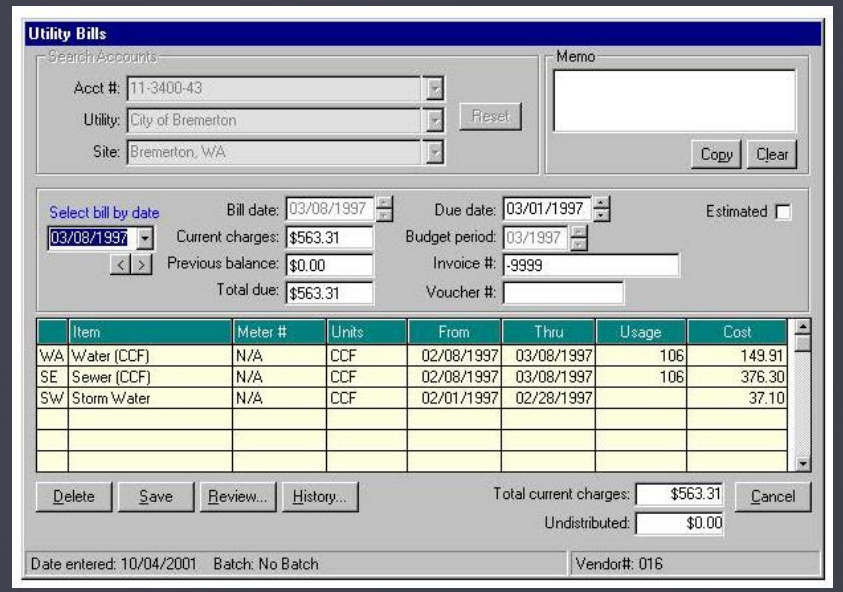
- Build Trust
- Train Staff
- Use What You Have
- Create Open Communication
- Track Your Energy
- Manage Your Energy
- Commission New Buildings
- Standardize Your EMIS’s
  - Get all needed software and licenses
- GOALS

Shannon Oliver, MPH

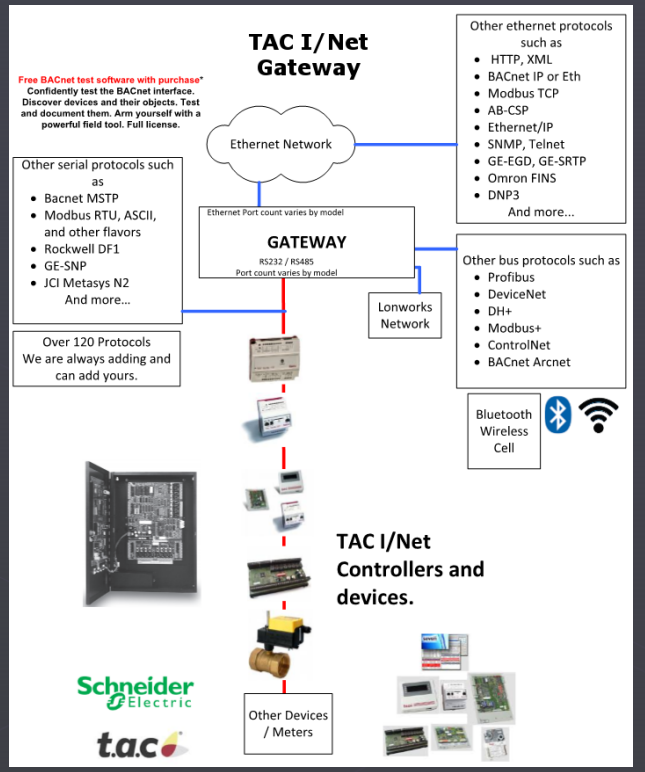
Adams 12 Five Star School

Efficient & Healthy Schools – a Smart Energy Management Journey

Starting with the Basics



- Manual processes
- Little-to-no integration
- Minimal benchmarking



A challenge to the old ways

- Renew Our Schools Energy challenge
- eGauge growth
- A winning bond effort!

https://egauge44487.egaug.es/616DC/classic.html

Sparking a new conversation

- Utility rebate program for support and guidance
- eGauge, EasyIO, and SkySpark integration
- Lessons learned

Analyzing a Future Path

- Shifting to BAS analytics
- Pandemic response and reaction
- Next steps

Contact: Shannon.t.oliver@adams12.org

Thank you!

QUESTIONS?

www.adams12.org/sustainability

EFFICIENT AND HEALTHY SCHOOLS

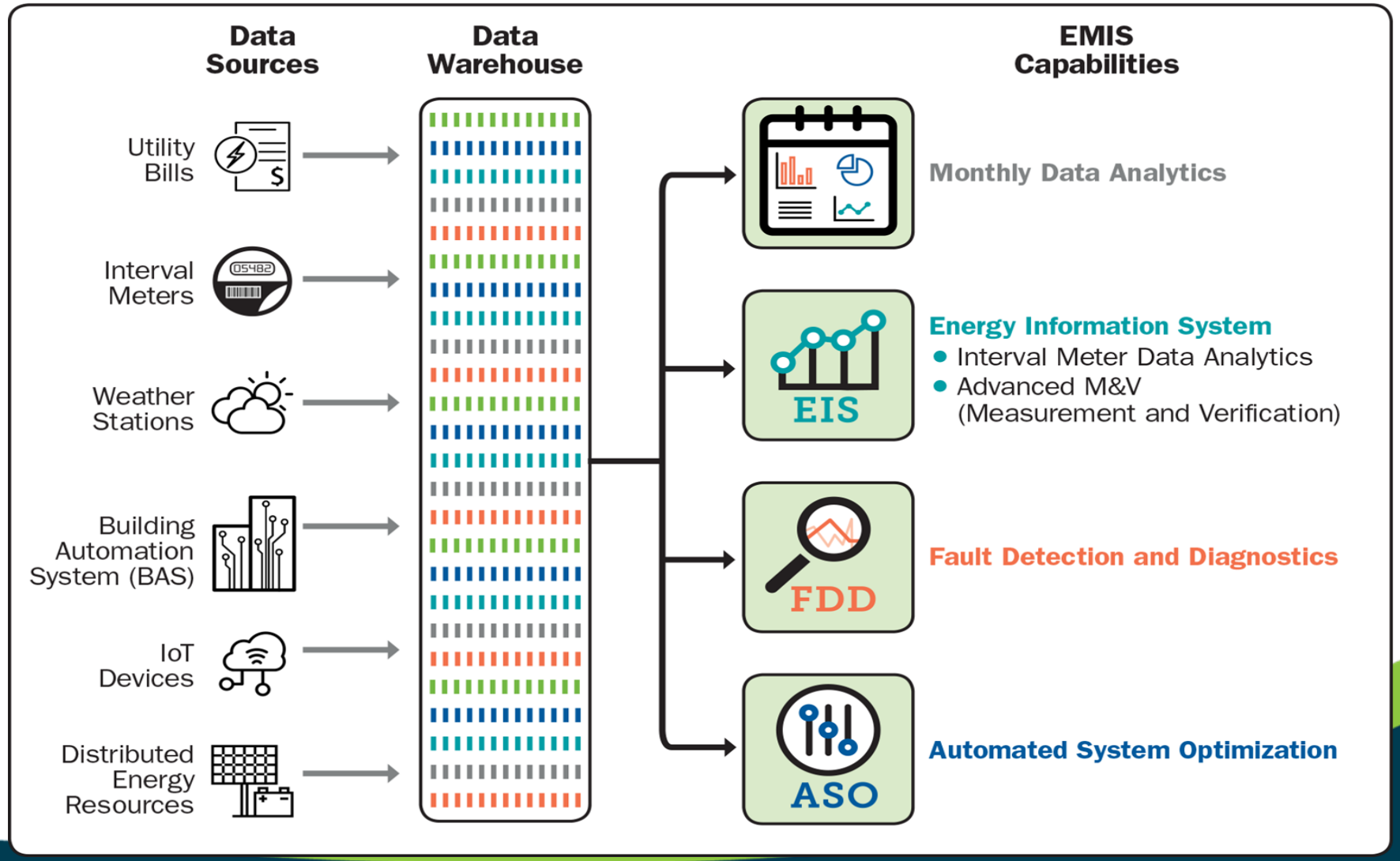
EMIS Displays, Solutions, and Results

David Landman, Lawrence Berkeley National Laboratory Affiliate

May 6, 2022

EFFICIENT AND HEALTHY SCHOOLS

Energy Management Information Systems (EMIS) Overview



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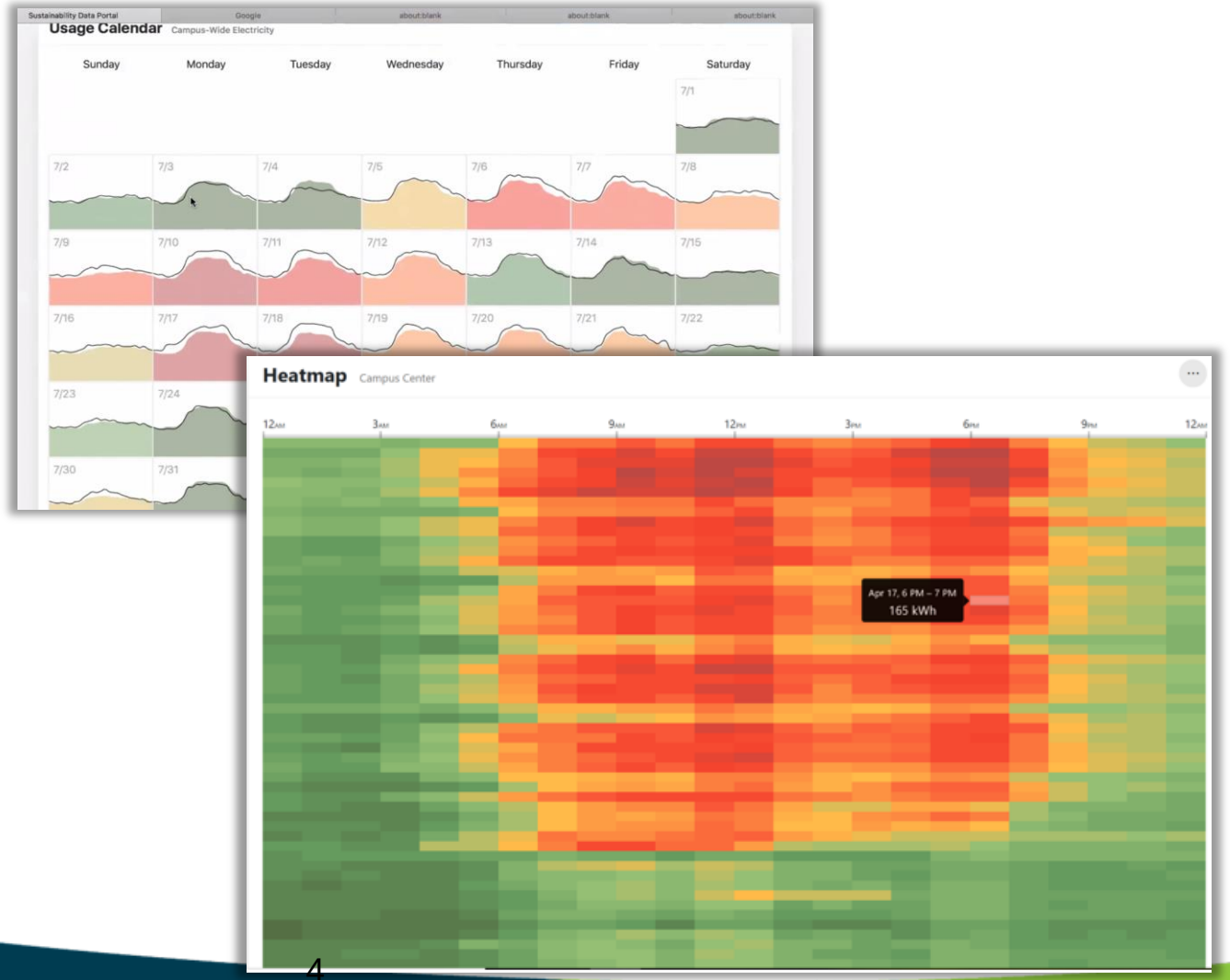
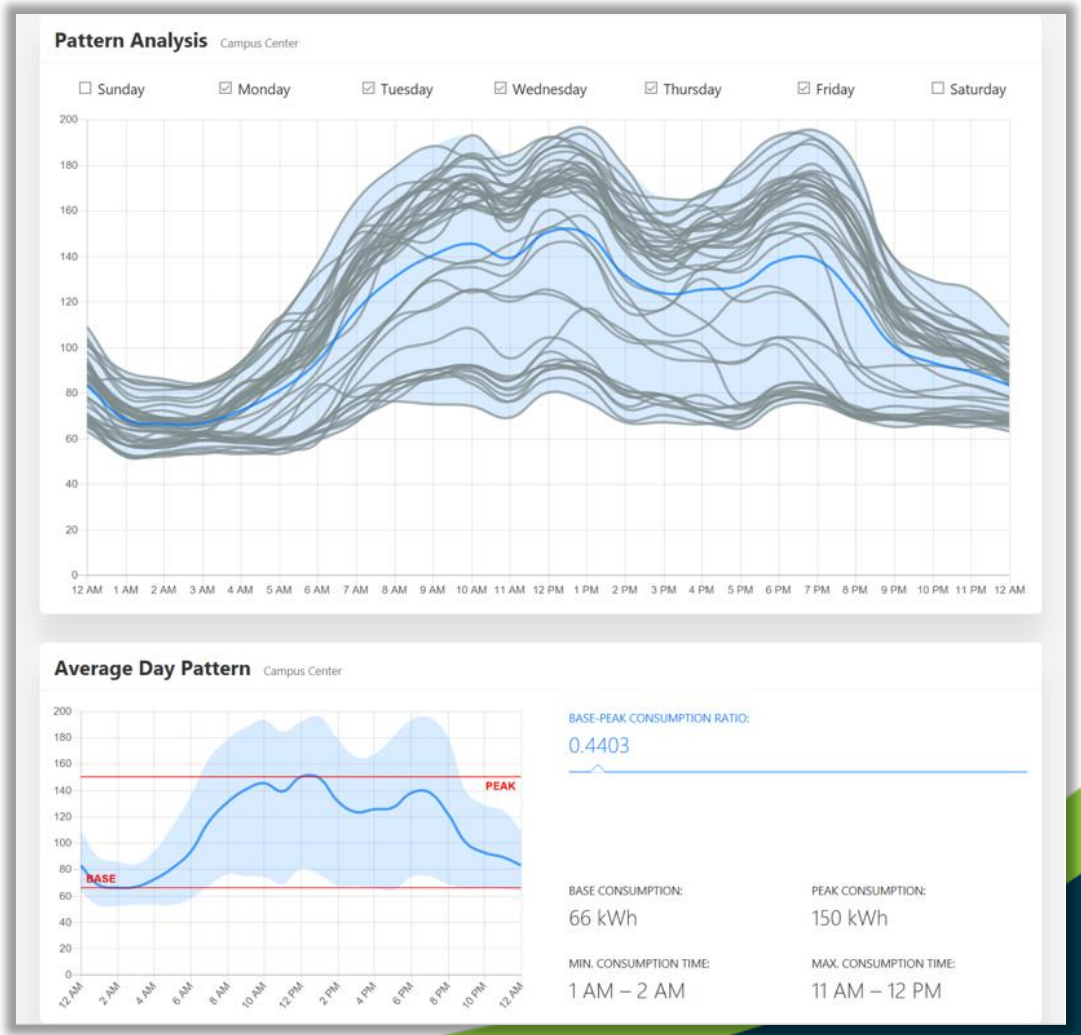
Summary of EMIS Tools

	EMIS Capability	Data scope	Key uses	Costs	Whole-building energy Savings
Whole building	**Monthly data analytics**	Monthly utility bills	▪ Peer-to peer comparison ▪ Utility bill data acquisition & analysis ▪ Budgeting ▪ Tenant billing	$-$$	2.4% median
Whole building & submeters	**Energy information system (EIS)**	Hourly or 15-min energy meter data	▪ Benchmarking & energy dashboard ▪ Building load analysis ▪ Energy anomalies alert ▪ Peak demand reduction ▪ Automated M&V	$$ Base: $0.01/sq ft Annual: $0.01/sq ft	3% median, portfolio-level $0.03/sq ft
System	**FDD**	15-min or less interval data from BAS and meters	▪ System-level performance tracking (KPIs) ▪ Automated fault detection & notification ▪ Fault causes identification ▪ Issues tracking	$$$ Base: $0.06/sq ft Annual: $0.02/sq ft	9% median, portfolio-level $0.24/sq ft
	ASO	15-min or less interval data from BAS and meters Supervisory control to BAS	▪ Optimal HVAC settings prediction	$$$$ Higher than FDD	Field validations in progress

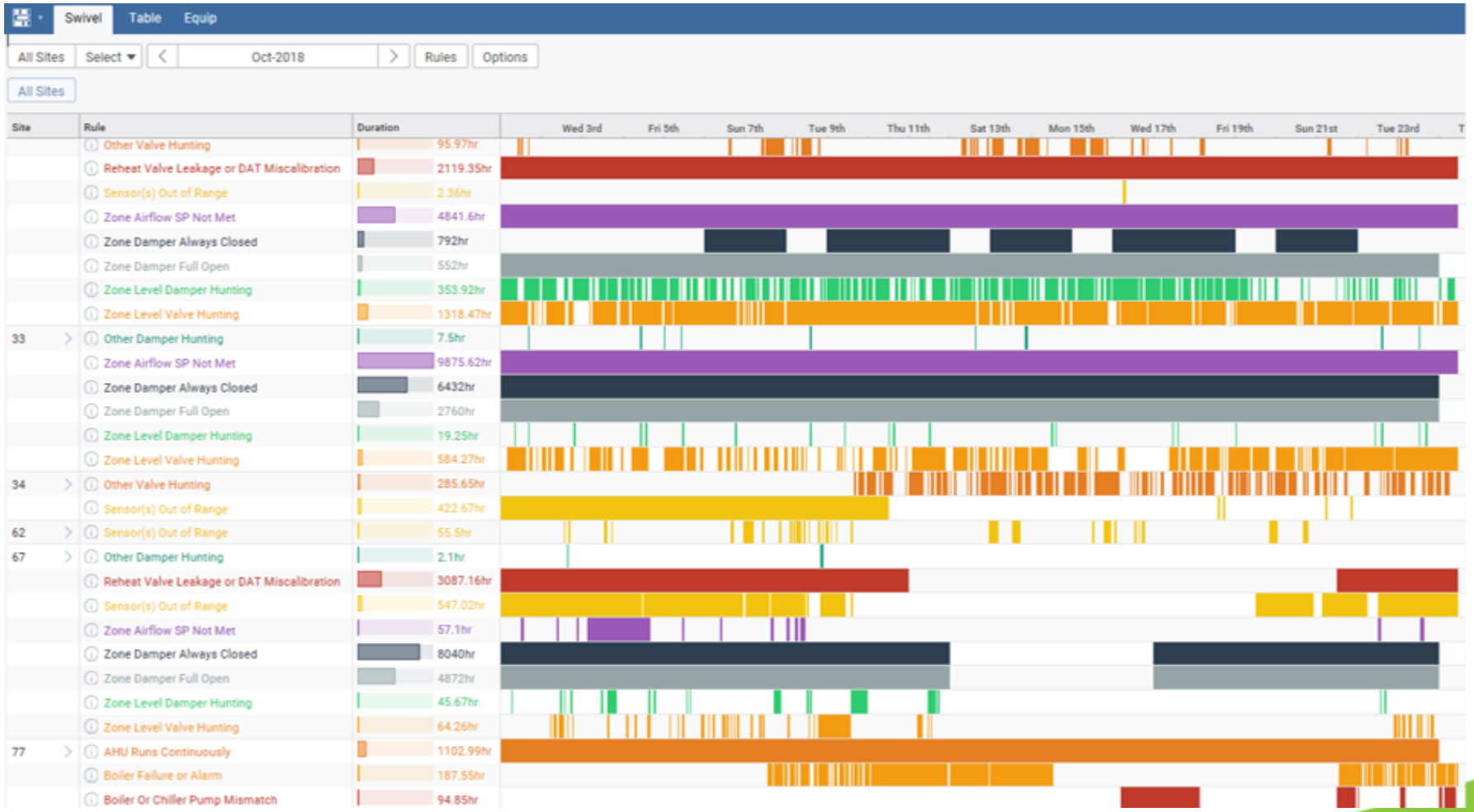
Examples of EIS Drill Down





Source: Macalester College

Fault Detection and Diagnostics (FDD) Issues List



Source: LBNL (SkySpark)

EFFICIENT AND HEALTHY SCHOOLS

FDD Output: Prioritization by Energy, Comfort, Maintenance

Diagnostics

The Diagnostics module provides a prioritized, searchable list of identified faults and energy saving opportunities across your portfolio.

Search Criteria

Generate Data

Download Current Diagnostics Page

Download Full Diagnostics Results

16525 data records found for 9/8/2019 to 9/8/2019 in daily intervals.

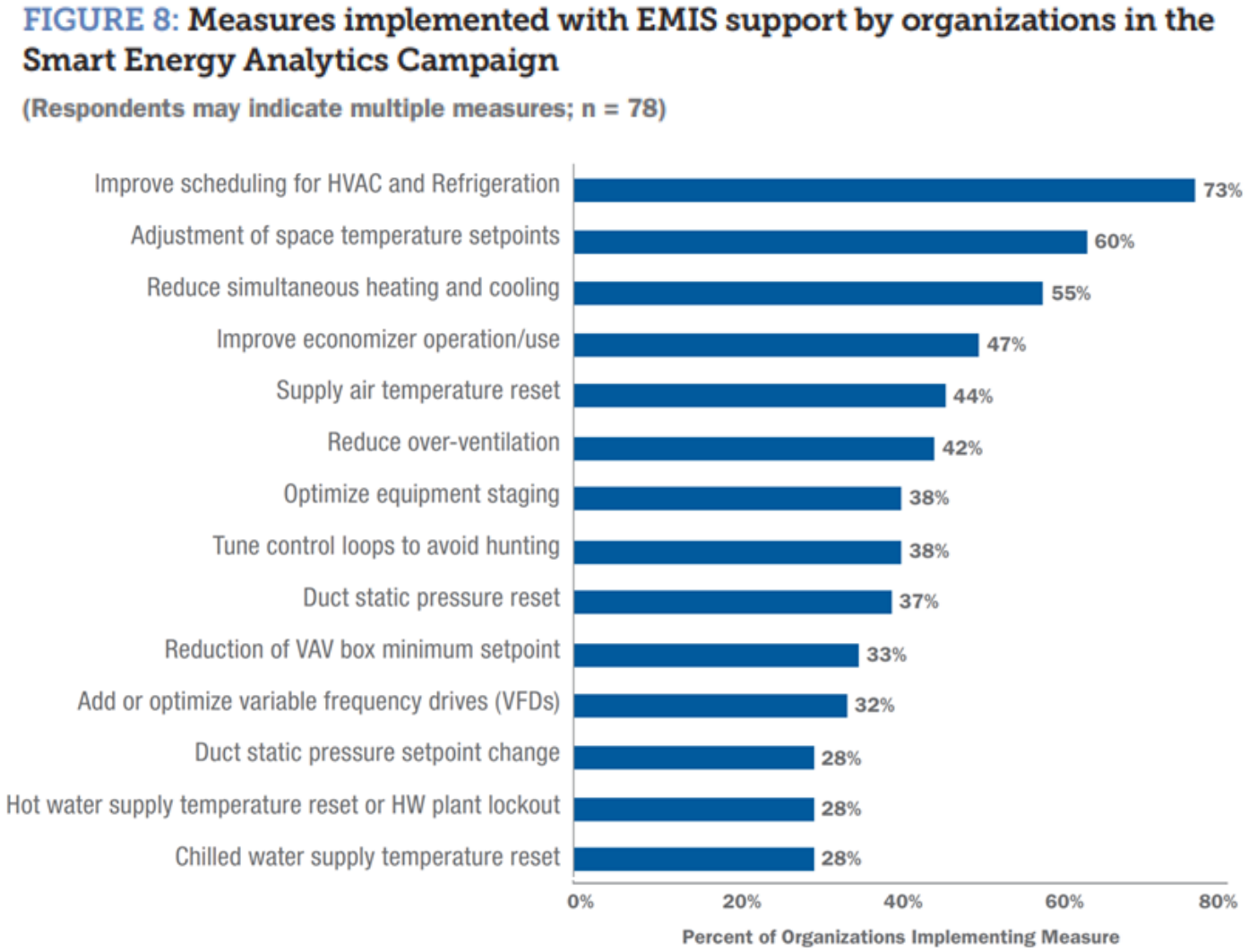
Building	Equipment	Analysis	Start Date	Notes Summary	Tasks	Cost	E	C	M	Actions
Moanalua Central Plant	CHWS (Cooling System)	CHW Loop	9/8/2019	Diff pressure higher than setpoint. Low supply temp. Out of range sensor error (low). Flat sensor error. Configuration flag.	2	$590	10	0	6	▼
Roseville Hospital	AHU-4 (Air Handler)	AHU Fan	9/8/2019	No static pressure reset. Flat sensor error.	0	$122	10	0	2	▼
Roseville MOB1 - Building D	AHU-1 (Air Handler)	AHU Fan	9/8/2019	Fan on while unoccupied. Supply static pressure smaller than setpoint. Flow sensor error.	0	$74	10	0	6	▼
Redwood City CUP	CUP.CW (Cooling System)	CW Loop	9/8/2019	Tower staging opportunity. Supply temp higher than setpoint.	1	$63	10	0	5	▼
Roseville CUP	PCHWS (Cooling System)	CHW Loop	9/8/2019	Low supply temp. Out of range sensor error (low). Flat sensor error.	0	$57	10	0	2	▼
Roseville Hospital	AHU-2 (Air Handler)	AHU Fan	9/8/2019	No static pressure reset. Supply static pressure larger than setpoint. Filter pressure sensor error.	1	$55	10	0	6	▼
Roseville Folsom MOB	Hot Water System (Heating System)	HW Loop	9/8/2019	Minimal load across loop. Supply temp lower than setpoint.	1	$48	10	0	5	▼
Roseville MOB1 - Building D	AHU-2 (Air Handler)	AHU Fan	9/8/2019	Fan on while unoccupied. Flow sensor error.	0	$48	10	0	4	▼
South Bay South Hospital Ce...	PCHW (Cooling System)	CHW Loop	9/8/2019	Low supply temp setpoint.	0	$39	10	0	0	▼
Zion Medical Center	AH-14 (Air Handler)	AHU Heat Recovery	9/8/2019	Heat recovery should be off.	1	$37	10	0	0	▼
Moanalua Ancillary Building	A2-2-3-10-03 (Zone Equipment)	Zone Unit	9/8/2019	Leaking heating valve.	1	$34	10	0	4	▼

Source: Kaiser Permanente (Clockworks)

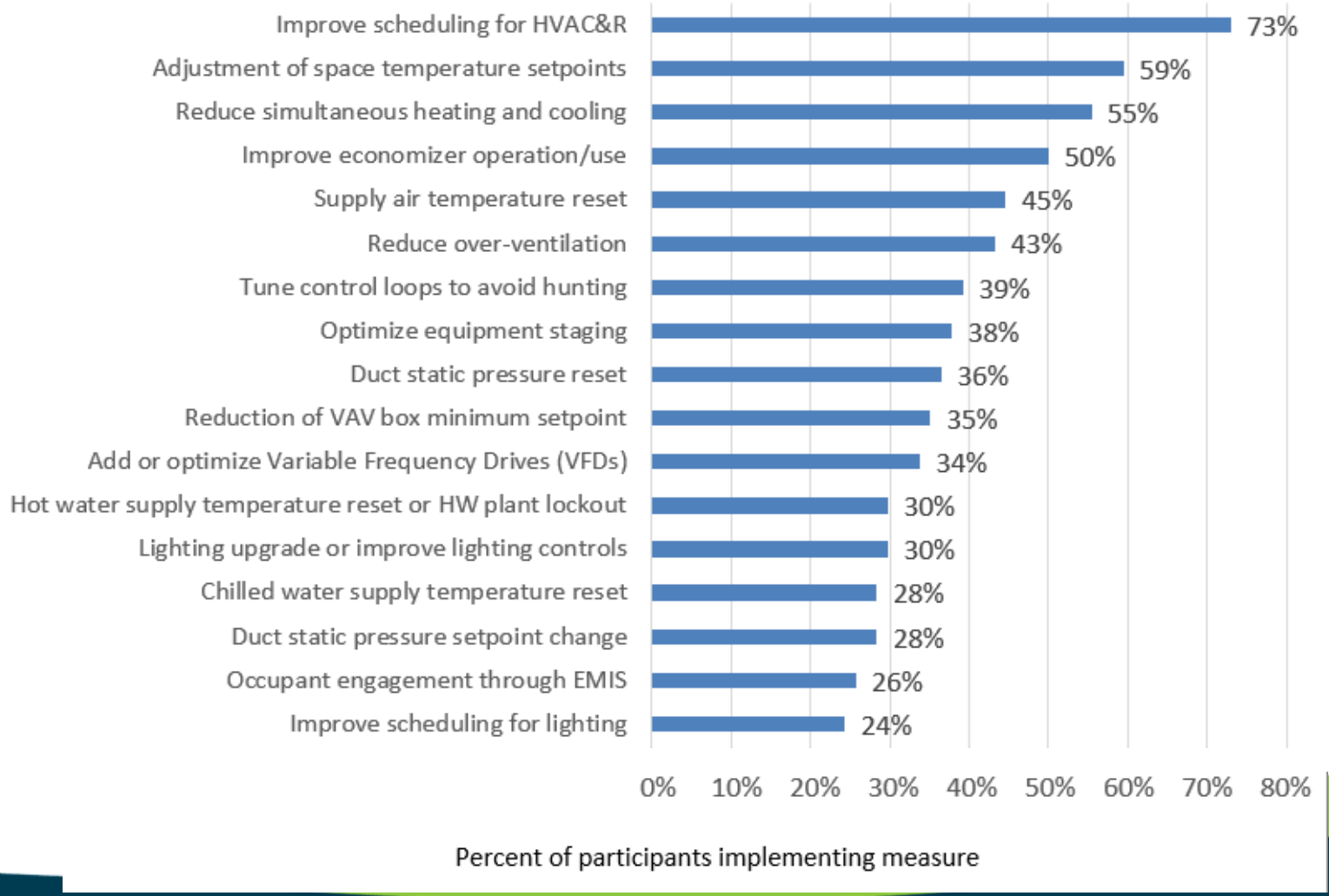
Top Faults

Faults from EIS data:
- Start/stop schedules
- Weekend/holiday energy use
- High baseload
- Demand spikes
- High energy use relative to portfolio or prior usage (modeled prediction)

Faults from FDD:
- Setpoints
- Simultaneous H&C
- Economizer
- Reset schedules
- Equipment staging/Control loop tuning



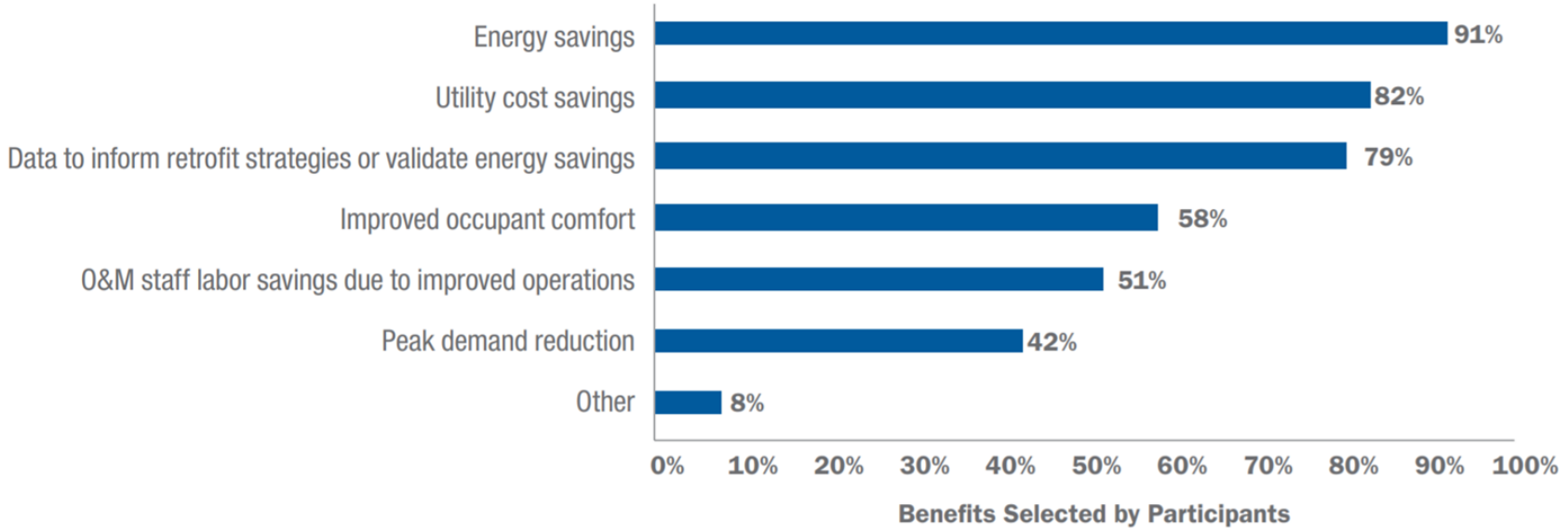
Top Measures Implemented with Support of EMIS
(74 organizations, 452 million sq ft)



Benefits of Implementing EMIS

FIGURE 7: Benefits of implementing EMIS

(Percent of time benefit was chosen by participating organizations, may select multiple benefits)



Keys to Successful EMIS: Commitment and Goals

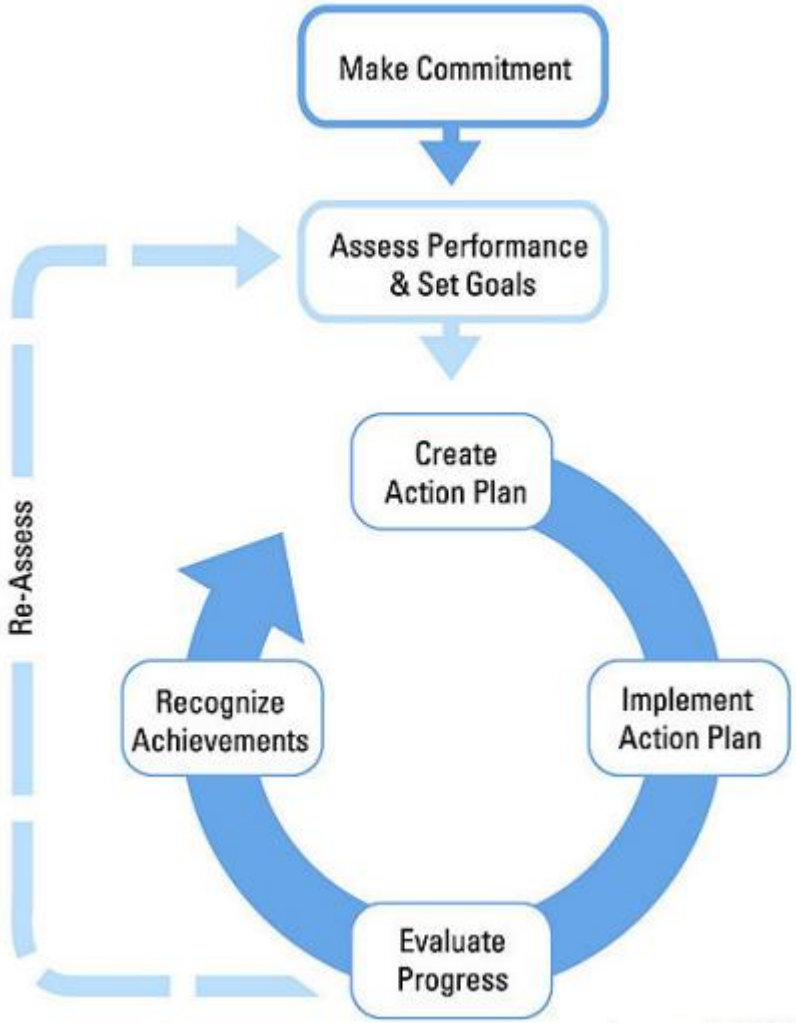
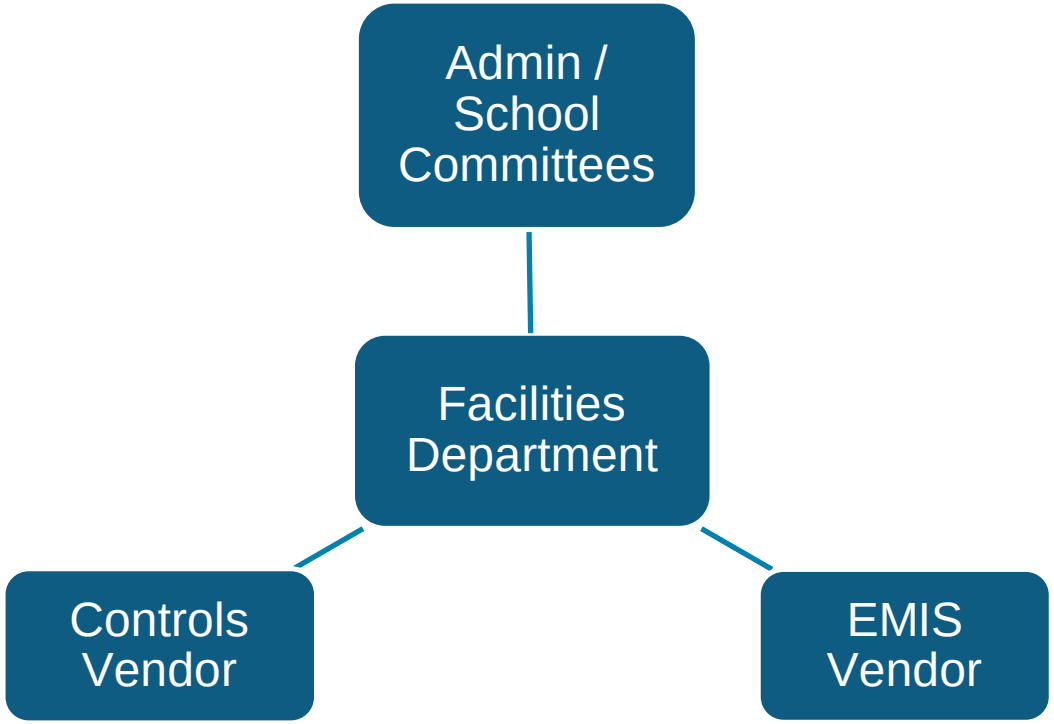


image credit: ENERGY STAR

- Commit to continuous improvement
  - Establish an energy team
  - Institute an energy policy
- Assess performance
  - Data collection and management
  - Analyze and evaluation
- Set goals
  - Determine scope
  - Estimate potential for improvement
- Create action plan
  - Define technical steps and targets
  - Determine roles and resources
- Implement action plan
  - Track and Monitor
- Evaluate progress
  - Measure results
- Recognize achievements
  - Internal and external, partnership programs

Keys to Successful EMIS: Team and Process



- Building Facilities Group
  - Implements O&M measures, coordinates with the Administration, EMIS and Controls Vendors
- Controls Vendor
  - Implements building automation system (BAS) programming changes
- EMIS Vendor
  - EMIS Vendor implements FDD modifications and additions
- Changes needs to be coordinated, documented, and updated

Best Practices and Keys to Success

Question

Best practices

Keys to success

Answer

- Good data
- Root cause analysis
- Reporting
- Communication

EFFICIENT AND HEALTHY SCHOOLS

EMIS Resources

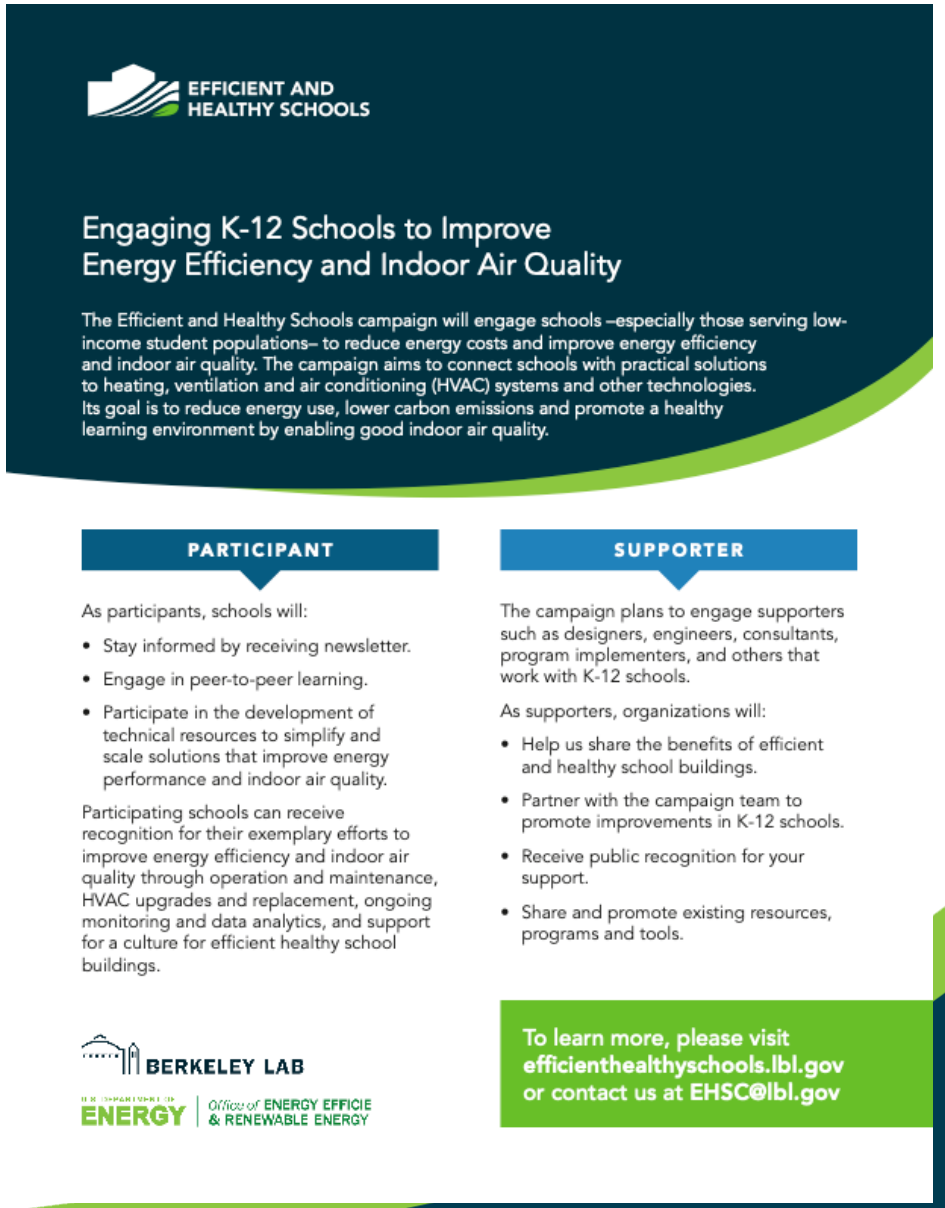
- A Primer on Organizational Use of EMIS
- EMIS Specification and Procurement Support Materials
- Webinar: Final Results on Energy Savings, Costs, and Benefits from the Smart Energy Analytics Campaign
- Proving the Business Case for Building Analytics
- EMIS Applications Showcase
- Infographic: EMIS Offers Proven Savings and Return on Investment

Q&A

Contact us at EHSC@lbl.gov

Become a Participant or Supporter

- Access technical assistance and resources on best practices, guidance, case studies, and webinars
- Campaign prioritize schools serving low-income communities and in rural areas
- Campaign participants can receive recognition for their exemplary efforts to improve energy efficiency and indoor air quality
- Campaign supporters are encouraged to share and promote goals and benefits of efficient and healthy schools



EFFICIENT AND HEALTHY SCHOOLS

Engaging K-12 Schools to Improve Energy Efficiency and Indoor Air Quality

The Efficient and Healthy Schools campaign will engage schools –especially those serving low-income student populations– to reduce energy costs and improve energy efficiency and indoor air quality. The campaign aims to connect schools with practical solutions to heating, ventilation and air conditioning (HVAC) systems and other technologies. Its goal is to reduce energy use, lower carbon emissions and promote a healthy learning environment by enabling good indoor air quality.

PARTICIPANT

As participants, schools will:

- Stay informed by receiving newsletter.
- Engage in peer-to-peer learning.
- Participate in the development of technical resources to simplify and scale solutions that improve energy performance and indoor air quality.

Participating schools can receive recognition for their exemplary efforts to improve energy efficiency and indoor air quality through operation and maintenance, HVAC upgrades and replacement, ongoing monitoring and data analytics, and support for a culture for efficient healthy school buildings.

SUPPORTER

The campaign plans to engage supporters such as designers, engineers, consultants, program implementers, and others that work with K-12 schools.

As supporters, organizations will:

- Help us share the benefits of efficient and healthy school buildings.
- Partner with the campaign team to promote improvements in K-12 schools.
- Receive public recognition for your support.
- Share and promote existing resources, programs and tools.

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To learn more, please visit efficienthealthyschools.lbl.gov or contact us at EHSC@lbl.gov

EFFICIENT AND HEALTHY SCHOOLS

Next Webinar: May 20 Friday 1p (ET) / 10a (PT)

HVAC Inspection and Maintenance for IAQ

- Tracy Enger, EPA IAQ Tools for Schools Program, U.S. Environmental Protection Agency
- Chris Ruch, National Energy Management Institute (NEMI)
- Rodney Williams, Newark Board of Education, NJ
- Linda Mayfield, Mariposa County School District, CA